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(54) **METHOD FOR THE PRODUCTION OF III-V
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STAMFORD, CT 06905-5619 (US)**(21) Appl. No.: **10/872,902**(22) Filed: **Jun. 21, 2004****Related U.S. Application Data**(63) Continuation of application No. PCT/EP02/12799,
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Publication Classification(51) **Int. Cl.⁷** **A41G 1/00**(52) **U.S. Cl.** **428/21**(57) **ABSTRACT**

The invention relates to a method for the production of III-V laser components, whereby a III-V semiconductor layer is deposited on a silicon substrate in a process chamber of a reactor from a gaseous starting material. According to the invention, an economical method for the production of qualitatively high-grade laser may be achieved whereby, firstly, an Al-containing buffer layer is deposited on the Si substrate, in particular a Si(III) substrate, on which the III-V semiconductor layer, in particular, GaN is then deposited such that the lattice plane thereof runs parallel to the cleavage direction of the substrate, whereby, on cleaving the substrate plane-parallel layer, cleavage surfaces are formed.

METHOD FOR THE PRODUCTION OF III-V LASER COMPONENTS

[0001] This application is a continuation of pending International Patent Application No. PCT/EP02/12799 filed Nov. 15, 2002 which designates the United States and claims priority of pending German Patent Application Nos. 101 63 714.4 filed Dec. 21, 2001 and 102 06 750.3 filed Feb. 19, 2002.

[0002] The invention relates to a method for producing III-V laser components, in which a III-V semiconductor layer, for example gallium nitride, is deposited on a silicon substrate from gaseous starting substances, for example trimethylgallium, trimethylindium, trimethylaluminum, phosphine or arsine, in a process chamber of a reactor.

[0003] The deposition of III nitride semiconductors on substrates of a different type, such as for example sapphire, silicon carbide or silicon, is a cost-saving process, since this substrate material is less expensive than III-V substrate material. However, one problem of this process is the lattice mismatch of the layer on the substrate. Suitable selection of the substrate material for the layer material allows matching to be effected, for example gallium nitride grows at a position rotated through 30° with respect to the sapphire, and thereby eliminates part of the lattice mismatch. However, on account of this rotated growth there is no common fracture or cleavage direction for the layer and the substrate. The fracture line generally runs along the fracture line or cleavage line of the substrate, since the latter is considerably thicker than the layer deposited thereon. In the case described above, this leads to a rough laser facet which has to be reworked. Also, with laser mirrors produced in this manner, undesirable losses are produced in the event of, for example, a wet-chemical after treatment. The roughness of the laser mirrors or facets which are not precisely oriented lead to losses and thereby cause a high threshold current, which is associated with an increased thermal load in the subsequent component.

[0004] The invention is based on the object of providing an inexpensive method for producing high-quality lasers.

[0005] The object is achieved by the invention defined in the claims, in which it is substantially provided that first of all an aluminum-containing buffer layer is deposited on an Si substrate, in particular an Si(111) substrate. This is carried out by means of MOCVD. This buffer layer may consist of aluminum nitride and may be 20 to 100 nm thick. Then, in the same reactor and preferably without any further intermediate steps, the active III-V layer, preferably a III nitride layer, and particularly preferably a gallium nitride layer, or a sequence of such layers for component layers, is deposited on this buffer layer, in such a manner that the lattice plane of the layer runs parallel to the cleavage direction of the substrate. When the substrate is fractured, the fracture then

takes place along a crystallographically suitable surface. The fracture takes place substantially along one plane. The fracture or cleavage lines of the Si(111) substrate can then be selected in such a way that plane-parallel layer fracture surfaces are formed. These layer fracture surfaces then form the laser facets. The laser facets are therefore formed simply by breaking or cleaving. This is possible on account of the fact that the crystallographic fracture direction of the silicon substrate and of the structure based on gallium nitride coincide.

[0006] A pertinent factor in this context is the aluminum-containing seed layer. A seed layer of this type even allows gallium nitride which is matched in terms of fraction direction to be deposited on Si(001). The only problem in this case is the absence of common crystal symmetry.

[0007] If necessary, further, in particular electrically active, layers can be deposited on the layer sequence described above. The pertinent factor, however, is that the hexagonal crystal of gallium nitride is deposited on the cubic crystal lattice of the silicon with a corresponding crystal orientation, in such a manner that the natural fracture directions of the two crystals coincide in the plane in such a manner that plane-parallel laser facets are formed by simply fracturing the substrate along the natural fracture lines.

[0008] All features disclosed are (inherently) pertinent to the invention. The disclosure content of the associated/ appended priority documents (copy of the prior application) is hereby incorporated in its entirety in the disclosure of the application, partly with a view to incorporating features of these documents in claims of the present application.

1. Method for producing III-V laser components, in which a III-V semiconductor layer is deposited on a silicon substrate, in particular an Si(111) substrate, from gaseous starting substances in a process chamber of a reactor, wherein first of all an Al-containing buffer layer is deposited on the Si substrate, then the III-V semiconductor layer, in particular a GAN layer, and if appropriate further active layers, are deposited on the buffer layer, in such a manner that the lattice plane thereof runs parallel to the cleavage direction of the substrate, plane-parallel layer fracture surfaces then being produced by cleaving the substrate in the cleavage direction, and components in which the layer fracture surfaces form the laser facets subsequently being fabricated.

2. Method according to claim 1, characterized in that the buffer layer consists of AlN or AlN with the addition of one or more further elements from group III or V.

3. Method according to claim 1, characterized in that the buffer layer is a III-V semiconductor layer and is between 20 and 100 nm thick.

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